# CHAPTER 4

# ENGINEERING OPERATIONS

When you have read and understood this chapter, you should be able to answer the following learning objectives.

- Describe the scope of engineering operations.
- Explain the use of engineering performance standards.
- Explain the purpose of engineering readiness trials and inspections.
- Define the function of the Propulsion Examining Board.
- Define the function of the Board of Inspection and Survey.
- Explain the use of the engineering operating programs; EOSS, EOP, and EOCC.

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The Chief of Naval Operation (CNO) establishes the standards of readiness and preparedness for war required of all U.S. Navy ships. The standards require that the ship's organization, its material readiness, and the state of training be such that the ship performs its mission effectively and efficiently.

Each type commander designates the trials, inspections, and exercises the ships under his command need to maintain readiness and meet standards. The type commanders also present Battle Efficiency awards as incentives toward greater efficiency through competition. These awards are earned for merit in readiness evaluation, competitive exercises, and day-to-day operations. The awards are presented according to OPNAVINST 3590.4 and usually are presented annually. CNO may authorize additional awards for type commands, and he may suspend awards during periods of national emergency. See the type commander's directives for information concerning the Battle Efficiency requirements for a particular ship.

Engineering readiness (including damage control) plays a major role in the battle efficiency of any ship. The following list shows the principal components of engineering readiness:

- Reliability
- Fuel performance
- Feedwater and freshwater performance
- Trial performance
- Ability to control damage and engineering casualties.

This chapter provides detailed information on (1) sound engineering practices, both recommended and mandatory, (2) engineering trials and readiness inspections scheduled by the type commanders, and (3) material inspections and ship surveys conducted by the Board of Inspection and Survey (INSURV). This chapter deals mainly with steam propulsion plants, but parts of it also apply to diesel and gas turbine propulsion plants.

## SOUND ENGINEERING PRACTICES

The engineer officer is responsible for sound engineering practices within the engineering department, and he informs the commanding officer of casualties and other events that affect the ship's operations. Although the engineering officer is responsible overall, this chapter applies to all supervisory personnel in the engineering department who may be responsible for any of the duties described in the chapter. Those who apply sound engineering practices and follow operational directives will enjoy a safe, economical, efficient, and reliable plant. They'll also need less time to maintain it in that condition. This chapter deals with a steam plant, but parts of it also apply to diesel and gas turbine propulsion plants.

## GENERAL PROCEDURES

Operate the plant with the minimum variation in speeds, pressures, and temperatures consistent with operational commitments. A variation in the output of a single component can upset the steam cycle balance and require adjustments on stations throughout the plant. You can see the truth of this when you compare fuel consumption during economy trials with that during normal operations. Teamwork among watch personnel and competition between watches can improve fuel economy and overall plant performance and reliability. The following pages contain brief descriptions of the general procedures common to most engineering plants.

Ž Follow prescribed acceleration procedures. Built-in safety factors will protect the equipment if you accelerate rapidly only in emergencies, but routine abuse will overload the plant and reduce reliability. Correct use of the acceleration tables saves fuel and extends machinery life. It also provides a time standard the engine-room and fireroom watches and the officer of the deck (OOD), can use to develop into a smoothly functioning team.

- Combatant ships frequently operate below maximum speed, and they use only a fraction of the main turbines' power at those speeds. Determine the most economical speed and boiler combination for any operating condition that might arise. In doing so, follow the type commander's directives but allow for any contingencies that may override the need for economy.

- Keep accurate records of boiler feedwater and potable water consumption. Determine the ship's normal consumption and post it in tabular form at main engine control, where it will serve as a ready reference. Any unexplained or marked increase over the normal means a leak or faulty operation of the engineering plant, and you should correct the problem immediately. You can hold feedwater losses to a minimum if you take the following precautions:

  - Be sure the engineering crew is trained in the procedures used to transfer condensate and feedwater.

  - Be sure watch personnel keep a close watch on pump shaft glands, valve glands, drain collecting tanks, atmospheric exhaust, and all other possible sources of leakage.

  - Be sure operating personnel consult the watch in the spaces concerned before they take on make-up feed, run water down from deaerating feed tanks (DFT), or shift feedwater suctions.

- Keep boilers clean, inside and out. Soot and scale are efficient insulators that prevent optimum heat transfer and require a progressively increasing combusiton rate to maintain a steady steaming rate. The engineer officer should give this need his personal attention. He may delegate preliminary inspections, but he must make the final inspection.

- The use of distillate fuel reduces the need for fireside cleaning and maintenance, and it improves reliability. If the condition of refractory at 1800 hours is satisfactory with little or no deposit, and if you make periodic inspections, you often delay fireside cleaning until overhaul.

- You will nearly always have clean boilers if you follow the *Naval Ships' Technical Manual (NSTM)* instructions that are summarized in the following paragraphs:

  - Inspect boiler firesides every 1800 hours of steaming or more often if needed. Inspect and clean watersides between 1800 and 2000 hours of steaming or more often if needed.

  - Blow tubes before entering and after leaving port, and at least once each week underway. (Always get the OOD's permission before blowing tubes.)

  - Blow down boilers as needed to maintain the specified water analysis and avoid high concentrations of scale-forming salts. Surface blow steaming boilers as needed.

    After you secure a steaming boiler and allow enough time to reduce circulation caused by generation, give the boiler a series of bottom blows to remove suspended impurities and scale-forming salts.

    Take all possible measures to prevent oil contamination of the feed system and boilers. Be sure all engineering operating personnel understand the seriousness of oil contamination of boiler water, its possible causes, and the consequences.

- Dirty atomizers, contaminated fuel, and fuel at improper temperature may require excess air to maintain acceptable stack conditions. You must watch the condition of the fire (it should be yellow-orange or golden yellow in shade), as well as the condition of the

stacks, to determine the true state of combustion efficiency.

**NOTE:** In boilers using distillate fuel, excess air can cause abnormally high superheater outlet temperatures, especially on "D" type boilers. Be very careful to prevent leakage of air into a boiler. Air that enters a boiler at any place other than through a burner register does not contribute to furnace combusiton and may reduce combustion efficiency.

- Watch carefully for chloride contamination of the water in the boiler feed and condensate systems; it threatens the material integrity and operational readiness of the plant. Keep in good working order those means used to determine the chloride content of boiler water. Drill operating personnel frequently on the danger of, and the methods used to prevent, chloride contamination. Be sure the DFT is functioning properly to remove dissolved gases from the boiler feedwater.

- Conduct daily dissolved oxygen tests on water to steaming boilers and on the discharge side DFT if your ship has them. You don't want dissolved oxygen in any boiler, but it is particularly corrosive in boilers that operate at high pressures and high temperatures. The modern pressure-closed feed system is designed to keep the condensate and feedwater from being exposed to air, and the DFT is designed to remove a great deal of oxygen that becomes dissolved or entrained in the water. However, there are still many ways in which oxygen can get into the system and become dissolved in the water. For example, a defective DFT may allow the water to pass through without being deaerated. Incorrect operation of a DFT can have the same effect. Air can leak into the condensate and feed systems at various points and its oxygen can dissolve in the water. Failure to lay up idle boilers according to prescribed procedures is still another cause of dissolved oxygen. You can find more information on dissolved oxygen tests in *NSTM,* chapter 220.

- The Oil King and the engineering watch supervisors in the fireroom should be graduates of the Boiler Feedwater Test and Treatment Course. They should be certified to perform the feedwater tests and treatments that are prescribed by Naval Sea Systems Command (NAVSEASYSCOM) and the manufacturer of the boilers. Never assume that personnel who conduct these tests are competent, observe them personally and be sure.

- Always preheat the lubricating oil system before starting the engines. During operating periods, keep the oil from the oil cooler between 120 and 130 degrees to minimize bearing wear. Watch for overheated bearings, foaming or emulsified oil, the presence of bearing metal and other foreign particles in lubricating oil sumps, and the presence of rust on journals and gearing.

- When condensers and their auxiliary components are operated improperly, they can cause extensive loss of efficiency. Here are several examples.

  - When you use more than the required amount of cooling water, the condensate system pumps a large amount of heat overboard, and the boilers will have to replenish that lost heat. You'll get the same effect from recirculation of the condensate.

    Air leaks in the condenser or its components may overload the air ejectors and lower the vacuum.

  - Steam is wasted by fluctuating, or excess, steam pressure to the air ejectors and by steam-driven auxiliary pumps operated at higher-than-necessary speeds.

- When the weather is cold enough to require steam heat, try to operate ventilation motors in fresh air supply systems at slow speeds. If you must operate them at higher speeds, first secure the steam to preheater and reheaters, but never operate supply blower motors faster than necessary for comfort. It is usually more efficient to circulate fresh air in a compartment by operating the exhaust blower at a faster speed.

- Keep engineering spaces, equipment, and machinery clean–it is one of the most important sound engineering practices. Clean up trash and spilled oil to prevent accidents and fire. Keep machinery free of oil and dirt so oil and fuel leaks are easily visible. Repair all leaks promptly. NEVER hose down spaces above the level of the bilge deck plates–you may get water in electrical assemblies. Clean spaces, equipment, and machinery show pride in your work and your ship.

You can find information on performance data and operating limits of the plant's equipment and machinery in the *NSTM,* manufacturers' technical manuals, and the *Ship Information Book (SIB).* For older ships, look in the *General Information Book,* the *Piping System Instruction Book, the Record of Electrical Installations,* the *Electrically Operated Auxiliaries With Performance Data,* and *General Description of Electronics System Installation.*

## SAFETY PRECAUTIONS AND OPERATING INSTRUCTIONS

All personnel must know and observe general safety precautions. Those who perform particular duties or operations must know and observe the safety precautions for those duties or operations. Those who don't understand safety precautions, and those who ignore them, are equally at risk of injury that may end in disablement or death. Therefore, all supervisory personnel must emphasize safety as part of their daily supervisory duties. This is especially important during the training of new personnel when they are forming good or bad habits. The following points are particularly important for supervisors:

- Be sure that personnel are practicing safety on equipment and that the equipment is in safe operating condition. Check safety devices to be sure they are working. If any safety device is not working, have it repaired immediately or post a prominent warning until it can be repaired. Train personnel NEVER to disable a safety device for any reason. Handle violations immediately and give warnings or other discipline depending on the seriousness of the situation.

- Engineering machinery and equipment must be protected against improper, careless, and abusive operation. The best protection is, of course, a trained, competent, and responsible operator. If a properly trained operator is not available, you may have to use one who is unfamiliar with the proper operating procedures for an item of machinery. In that case, be sure you provide instructions. Also, be sure that operating instructions are readily available and that operating procedures and safety precautions are posted on or near the equipment. Manufacturers furnish technical manuals for their equipment. In addition, the NSTM chapters contain information on the best engineering practice for the operation, testing, and safety of shipboard machinery and equipment and for the safety of personnel. NAVSEASYSCOM furnishes newly constructed ships and conversions with standard and nonstandard operating instructions and safety precautions for material under their technical control. These instructions are suitable for posting. If your ship is already in operation, you may order plastic-laminated standard and nonstandard operating instructions and safety precautions from the *Navy Stock List of Publications and Forms*, NAVSUP 2002. Always inform the engineer officer if instructions and safety precautions are inadequate. He will inform the commanding officer, who will issue additional instructions as needed and inform NAVSEASYSCOM of the problem.

When engineering personnel work outside of the engineering department, the responsibility for training and enforcing safety precautions rests with the head of the department controlling the operation. For example, weapons and ammunition handling requires special instructions by the weapons officer.

The engineer officer has the following responsibility for safety in the engineering department:

- Be sure safety precautions are posted in a conspicuous and accessible places.
- Be sure all persons in the department and others who may be concerned with engineering matters observe safety precautions.
- Drill personnel in the safety procedures that apply to their work.

Each division officer has the following responsibilities for safety in his division:

- Instruct subordinates in all safety precautions that apply.
- Require subordinates to observe all safety precautions that apply.
- Post safety precautions and warnings in conspicuous places. This includes posting warnings on dangerous equipment and in areas of the ship where there are particular hazards.

Each member of the engineering department has the following responsibilities:

- Report unsafe conditions and correct the conditions where possible.
- Warn others of unsafe conditions.
- Use approved protective clothing and equipment where it is called for.
- Report injury or ill health to supervisors.
- Use caution in emergency conditions or other dangerous situations.

## WARMING-UP SCHEDULES

Warming-up schedules for propulsion machinery and boilers are chronological checklists of the key steps used to light boiler fires and warm up the ship's main engineering plant. These steps are necessary to get the

ship under way according to the general degree of readiness in effect. The type commander prescribes the format for each warming-up schedule. (A sample engine-room warming-up schedule is shown in fig 4-1.) The scheduled times relative to the time of reporting ready are printed on the form. You should enter the required and actual clock times in pencil. In figure 4-1, the column titled ALLOWED shows the time (relative to reporting ready) scheduled for each operation. The second column is the projected time sequence for each operation to be carried out to meet the underway time. The third column is the actual time required for each operation.

The warming-up schedule is a proven way to minimize confusion, establish orderly procedures, and provide assurance that the steps will be performed in the proper sequence. You can use them without regard for the experience of the personnel involved. The engineer officer examines completed warming-up schedules and disposes of them according to the type commander's instructions.

Warming-up schedules are not required on ships governed by the Engineering Operational Sequencing System (EOSS). However, the engineer officer may prefer to use the schedules for his own purposes or files.

WARMING - UP SCHEDULE FOR FORWARD ENGINEROOM DATE 6 JUNE 19-

USS EXAMPLE (CAG-132)

| Commence warming-up at | Underway at | Standard speed will be | Signature: |
|---|---|---|---|
| 0530 | 0800 | 15 KNOTS, 141 RPM | F. E. Johnson |

| TIME | | | OPERATION |
|---|---|---|---|
| ALLOWED hr.:min. | CLOCK | ACTUAL hr.:min. | |
| -2 : 30 | 0525 | -2:35 | Station the engineroom steaming watch. |
| | 0527 | -2:33 | Take and record counter readings in Bell Book. |
| | 0527 | -2:33 | Take and record turbine clearances in Engineering log. |
| | 0530 | -2:30 | Electrician's mates energize all underway power and I.C. circuits. |
| | 0530 | -2:30 | Crack all funnel drains. |
| | 0540 | -2:20 | Cross-connect auxiliary steam and exhaust condensate lines. |
| | 0540 | -2:20 | Cross-connect salt water cooling and H.P. drain systems. |
| | 0542 | -2:18 | When steam pressure reaches 50 psig, cut in H.P. drain traps and close funnel drains. |
| | 0542 | -2:18 | Open main condenser overboard and injection valves and vent salt water chests. |
| | 0543 | -2:17 | Open all main propulsion trubine casing and chest drains. |
| | 40 | -2:20 | Back off main throttle valves, throttle by-pass and nozzle valves. Re[illegible] wrong direction |
| 15 | 0740 | -0:75 | Open bulkhead main steam |
| | 0745 | -0:15 | Split main steam, auxiliary steam, auxiliary exhaust, H.P. and drains, condensate, main feed, salt water cooling main, and fire main. |
| | 0740 | -0:20 | Request permission from OOD to test main engines. |
| | 0750 | -0:10 | When permission is granted, disengage turning gear. |
| | 0752 | -0:08 | Open guarding valves and test main engines. Test ASTERN operation first and make certain not to put way on the ship. |
| 0 : 00 | 0803 | +0:03 | Report engineering department ready for getting underway to OOD and engineer officer. |
| | 0806 | +0:06 | Request permission of OOD to spin main engines every 3 minutes. |
| +0 : 15 | 0829 | +0:29 | Underway. |
| +0 : 20 | 0834 | +0:34 | Close turbine drains. |

REMARKS: NO. 2 FIRE AND FLUSHING PUMP IS OUT OF COMMISSION.

| WATCH SUPERVISOR: | Examined (Engineer Officer) |
|---|---|
| E. B. Parker, MMC, USN | F. E. Johnson |

**Figure 4-1.-A sample warming-up schedule for an engine room.**

On ships that are not governed by EOSS, the warming-up schedule is mandatory.

## SECURING SCHEDULES

Securing schedules for propulsion machinery and boilers are chronological checklists of key steps. They are used to secure the ship's main engineering plant according to the general degree of readiness in effect. The respective steps may be scheduled relative to the time orders are received to secure the engine room or boiler. The securing schedules should list the auxiliary machinery to be used after securing the main engineering plant. The securing schedule must be according to the type commander's directives. A securing schedule overcomes the normal tendency to secure machinery too quickly. Securing schedules should be used without regard for the experience of the personnel involved. The engineer officer examines completed securing schedules and disposes of them according to the type commander's directives.

Securing schedules are not required for ships govered by EOSS, but they are mandatory on all other ships.

## PERFORMANCE STANDARDS

CNO and the type commanders require certain engineering trials and inspections to determine that standards are being met and to evaluate the operational readiness of ships of the type. CNO and the type commanders determine the frequency of the engineering readiness trials and inspections.

Engineering readiness trials include full-power trials, fuel-economy trials, and basic engineering casualty control exercises (BECCES). BECCES serves the same purpose as engineering operational casualty control (EOCC) which will be discussed at the end of this chapter. Readiness inspections include the administrative inspection, the material inspection, and the operational readiness inspection.

## ENGINEERING READINESS TRIALS

Engineering readiness trials (full-power and fuel-economy trials) are required by CNO and prescribed in *Ship Exercises,* FXP3, and in the type commander's directives, which contain specific requirements for the exercises and trials. The commanding officer conducts these trials periodically according to those instructions. The type commander, a commander subordinate to the type commander, or the task force commander may assign observers for the engineering trials. These observers will come from another ship of the same type whenever practical. There may be times when it is impractical to provide observers from another ship. In those cases, personnel from the ship conducting the trial may act as observers subject to the type commander's requirements for self-observation of trials.

The number of personnel assigned to observe engineering trials will vary according to the trial and the size and type of ship being observed. The duties of the observing party are usually as follows:

- The chief observer will organize, instruct, and station the observing party. He checks the ship's draft, either at the beginning of the trial or before leaving port; supervises the performance of the engine-room observers; checks the taking of counter reading; renders all decisions according to current directives; and checks and signs the trial report.

- The assistant chief observer helps the chief observer as directed; supervises the performance of the fireroom observers; checks the taking of fuel oil soundings and meter reading; and makes out the trial report.

- Assistant observers review fuel soundings and meter readings, counter readings, the ship's draft, and other data as may be required for the trial report.

The following items should be accomplished or considered before starting the trial:

- When requested by the observing party, the ship being observed provides a signaling system that will allow fuel soundings and the readings of counters and meters to be taken simultaneously.

- The ship being observed will furnish the chief observer with a written statement of the date of last undocking, the authorized and actual settings of all main machinery speed-limiting devices and the status of safety device test and inspections. The ship's draft, trim, and loading must conform to trial requirements. In case a minimum draft is not specified, the liquid loading should equal at least 75 percent of the full-load capacity at the beginning of the trial.

- The chief observer determines draft and trim before and after the trial. He verifies the amount of fuel on board and corrects the amount to the time the trial begins. He determines the full-power rpm required for the displacement and injection temperature existing at the start of the trial.

- The observing party must be instructed to detect and promptly correct any errors in the recording of trial data. It is important that the data be correct within the limits of accuracy of the shipboard instructions.

- The chief observer should instruct members of the observing party to report any violation of trial instructions found in the NSTM or of sound engineering practice. The chief observer should verify any such report and then inform the commanding officer of the ship being observed. He must also include in the trial report a detailed account of any violation.

Before beginning a full-power trial, engineering personnel should hold inspections and test machinery and equipment to be sure no material item will interfere with the trial. The extent of the inspections and the tests will largely depend upon the recent performance of the ship at high speeds, the material condition of the ship, and the time limits imposed by operational commitments. The type commander's instructions will provide requirements in most cases.

Inspect and test reactors, boilers, main engines, pumps, auxiliary machinery, safety devices, piping systems, and all equipment necessary for the proper operation of the engineering plant. Make the inspections and test according to the Planned Maintenance Subsystem (PMS), which prescribes tests and inspections for machinery and equipment. If there are no PMS instructions, use the manufacturer's technical manuals. If you have no specific instructions, follow sound engineering practice.

Not later than 1 day before a trial, the engineer officer should report to the commanding officer the condition of the main engineering plant. He should state that the plant is fit to proceed with the trial, or that it is not fit, and the reasons why. The trial must be postponed if the commanding officer believes that holding the trial might damage or disable the engineering plant or cause a personnel casualty.

During the full-power trials, the following general rules must be observed: (The rules also apply to other machinery trials that may be held under the conditions imposed.)

- Gradually increase the speed of the engines to the speed specified for the trial. Be sure to thoroughly warm up the machinery before beginning a full-power trial. Do this by operating at a high fractional power long enough to stabilize temperatures.

- Operate the machinery economically and do not exceed designed pressures, temperatures, and speeds.

- Do not conduct a high-speed trial in shallow water. It causes excessive vibration and loss of speed, and it overloads the propulsion plant. The *NSTM* has information on the proper depth of water for a specific ship.

• If it is desirable to continue a full-power trial beyond the duration originally specified, continue the observations until the trial is finished. Conduct the trial continuous without interruption. If a trial at constant rpm is discontinued for any reason, count it unsatisfactory and start a new trial. There can be no major changes of the plant set-up or arrangement during economy trials.

- During full-power or economy trials, record all necessary data often enough to obtain a reasonably correct picture of the power developed and the fuel and water consumed during the trial. You can compute the average power developed by diesel-electric plants from the kilowatt output of each propulsion generator set. Make observations at intervals not greater than one-half hour, and make at least three observations regardless of the duration of the trial. In ships equipped with torsion meters, make at least 10 torsion-meter observations at half-hour intervals.

The Deputy Chief of Naval Operations for Fleet Operations and Readiness furnishes trial requirements for each ship to the commanders and units concerned. They cover engine speed for full power at various displacements and injection temperatures.

They also furnish the shaft rpm corresponding to 15, 20, and 25 knots for the appropriate ships.

Full-power trials for competitive purposes are 4 hours long, as far as the report data are concerned. However, some restrictions may be placed on a given trial because of fuel economy requirements. Check type and fleet commanders instructions for the latest requirements. The usual procedure is to operate the ship at full power until all readings are constant, and then start the official trial period. Economy trials are 6 hours, and each trial is conducted at a different speed.

Trials once scheduled should be conducted unless prevented by circumstances such as those in the following list:

- Weather that might damage the ship

- Material trouble that stops the trial, or that might cause damage to the machinery or personnel if the trial were continued

- Any situation that would endanger human life if the trial were conducted

If a trial performance is unsatisfactory, the ship will normally be required to hold another trial that the type commander feels will demonstrate satisfactory engineering readiness.

If a ship failed to make the required rpm for any hour during the trial, that should be noted in the trial report along with the amount by which it failed.

Some of the requirements pertaining to the manner of conducting full-power and economy trials are as follows:

- Unless otherwise ordered, the ship may start a full-power trial at any time on the date set.

- Divide the trial into hourly intervals, but take and record readings at least every half hour. Submit data as hourly readings in the trial report. Record full-power (modified) trial data every 15 minutes.

- Determine fuel expenditures for each hourly interval of the trial by the most accurate means available. This usually means meter readings corrected for meter error and verified by soundings.

- Maintain the appropriate material condition of the ship during the different trials.

- Provide normal ship's services during all of the trials.

- Check and synchronize all clocks in the engineering spaces and on the bridge before beginning the trial.

It is common practice for many commanding officers, when conducting full-power trials, to bring the ship up to a speed several knots below the trial speed of the ship, and then to transfer control of the ship's speed (except in an emergency) to the engineer officer until the specified speed is attained. The control engine room, under the supervision of the engineer officer, brings the speed up slowly, depending upon the conditions of the plant, until the specified speed has been reached. The commanding officer instructs the OOD or navigator to avoid the use of the rudder and to try not to change course unless it becomes necessary.

In most ships with oil-fired boilers, the designed boiler power is the first factor that establishes a ship's maximum speed. For that reason, it is necessary to check boiler steaming conditions before ordering addional turns. Do not load the boiler faster than it can handle the increased load. Maintain the steam pressure and temperature at full value for the appropriate steaming condition. The boilers should be the controlling factor and must be kept ahead of the turbines. If the turbines are allowed to get ahead of the boilers, the main steam pressure and temperature will drop below normal values for that particular steaming condition or speed of the ship. Then, to make up this loss in steam pressure and temperature and to meet additional increases of speed that may be necessary, the boilers must be fired at an extremely high rate. In some ships, the necessary firing rate may exceed the full-load rating of the boiler and approach the maximum 120 percent overload capacity rating of the boiler. As far as the engineering plant is concerned, the purpose of the acceleration table is to prevent overloading the boilers. The acceleration table is of particular importance when accelerating near full speed and full power.

Review OPNAVINST 9094.1 for all requirements and other information needed to make reports on fill-power and economy trials. Use OPNAV Forms 9094.1A, 9094.1B, and 9094.1D to make reports on these trials. See the type commanders instructions for additional information.

## READINESS INSPECTIONS

When a ship undergoes an administrative, material, or operational readiness inspection, the type commander will appoint an inspection board, usually from another ship of the same type, whose personnel will help conduct the inspections.

The chief inspector (generally the commanding officer of the assisting ship) organizes the inspection board. The organization usually conforms to the administrative organization of the observed ship. The inspection board is divided into parties, each headed by a senior inspector. The engineer officer of the assisting ship usually heads the engineering inspection party. That party usually is divided into three groups: machinery (including main propulsion), electrical, and damage control.

The type commander usually furnishes checklists to help observers conduct readiness inspections. Engineering checklists are usually divided into three sections: machinery (main propulsion), electrical, and damage control. These checklists may not be all inclusive, and the inspection may show a need to consider other items.

After the inspection, the inspection team holds a critique to inform the ship's officers of conditions and to recommend improvements.

The evaluation of a readiness inspection is based upon how well the ship's personnel and material are ready to carry out the ship's mission. The senior observer for each department recommends a tentative overall grade for the department. The type commander or his designated subordinate awards a final grade that aims at uniformity for the type. The grading system is as follows:

| | |
|---|---|
| Outstanding (95.0 - 100) | No superior ships in the type to the knowledge of the inspector. |
| Excellent (88.0 - 94.9) | Few minor deficiencies. So markedly above the required minimum standards as to be among the few best. |
| Good (75.0 - 87.9) | Some minor deficiencies, but above required minimum standards. |
| Satisfactory (62.0 - 74.9) | At required minimum. Capable of performing assigned functions. |
| Unsatisfactory (0.0 - 61.9) | Below required minimum due to a vital or critical deficiency or a culmination of minor deficiencies. |

In the following paragraphs, we'll discuss each of the three types of inspections: administrative, material, and operational readiness.

**Administrative Inspection**

An administrative inspection evaluates how well a ship implements prescribed administrative procedures. Consult current type commander directives when preparing an administrative inspection. An administrative inspection reviews the general administration of the ship as a whole.

An administrative inspection of the engineering department is primarily an inspection of the departmental paper work. This includes publications, bills, tiles, books, records, and logs. However, the inspection will also include other items such as the cleanliness and preservation of machinery and engineering spaces, the training of personnel, the assignment of personnel to watches and duties, the proper posting of operating instructions and safety precautions, the adequacy of warning signs and guards, the marking and labeling of lines and valves, and the proper maintenance of operating logs. The following items will be graded for the engineering department:

- Cleanliness, sanitation, smartness, and appearance of the department
- Appearance, bearing, and smartness of personnel
- Adequacy and condition of clothing and equipment of personnel
- General knowledge of personnel in regard to the ship's organization, orders, and administrative procedures
- Dissemination of all necessary information among the personnel
- Indoctrination of newly reporting personnel
- General educational facilities for individuals
- Comfort and conveniences of living spaces, including adequacy of light, heat, ventilation, and fresh water, with due regard for economy

**Material Inspection**

A material inspection evaluates the actual material condition of a ship, including the proper functioning of all equipment, machinery, and fittings. The inspection helps to determine whether proper procedures have been followed. If the inspection shows a need, the inspecting team will recommend repairs, alterations, changes, or developments that will ensure the material readiness of the ship.

The type commander's material inspection will be similar to that made by the INSURV board discussed later in this chapter. The inspection should be thorough and searching, and it should cover detailed maintenance and repair rather than general appearance. There should be little duplication of effort between the administrative inspections and material inspections. The maintenance records and reports should show the current data and history the inspection team needs to understand the condition of machinery and equipment.

The following paragraphs contain a brief listing of the requirements for material readiness that should be evident to the inspection team through records or direct observation.

- Establish routines according to type commanders' instructions for inspections and tests, schedules for preventive maintenance, and a system for timely and effective repairs.

- Keep adequate material maintenance records according to current directives; these should show the

history and detailed condition of machinery and equipment.

- Plan and use the ship's facilities effectively to maintain, repair, and preserve equipment and machinery.

- Allocate work correctly to the following functions: (1) the ship's force, (2) the tenders and repair ships, and (3) naval shipyards or other repair activities.

## PROPULSION EXAMINATION BOARD (PEB)

The Atlantic and Pacific Fleet Commanders-in-Chief (FLTCINC) established PEBs to verify adherence to propulsion plant readiness standards and to ensure that these plants are operated properly and safely. OPNAVINST 3540.4 establishes the PEBs, describes their authority and responsibility, designates membership, and prescribes administrative procedures.

Each conventional PEB has the following responsibilities when its members examine propulsion plants:

- Evaluate the qualification of all propulsion plant personnel based on appropriate PQS.
- Witness and evaluate propulsion plant evolutions using the installed EOSS as a basic guide.
- Inspect the material condition of the propulsion plant for state of operational readiness, preservation, and cleanliness.
- Review and evaluate administration of the ship's engineering department and all records relating to the propulsion plant.

When the board completes an examination, it will submit an official written report to the appropriate FLTCINC, with copies to the type commander, appropriate administrative commander, immediate unit commander, and the examined ship. FLTCINC will forward a copy of the report of findings to CNO; the Chief of Naval Material; and the Commander, Naval Safety Center (when appropriate). The report will be submitted as soon as possible, but always within 30 days of the examination.

### Light-Off Examination (LOE)

The initial LOE is conducted under any of the following circumstances:

- Before lighting the first fire in any boiler or the first light-off of a main or auxiliary gas turbine
- Following major conversion of a ship
- On a ship qualifying for fitting out availability
- On a ship with restricted availability in excess of 4 months

In fulfilling its responsibilities, the PEB ascertains the state of training of propulsion plant personnel, the adequacy of administrative procedures, and the material readiness of the propulsion plant machinery spaces as they affect impending propulsion plant operations. Propulsion plant drills are not required to be conducted as part of this examination. For example, simple evaluation of boiler water and feedwater, fuel sampling and analysis, as applicable, and walk through casualty control drills may be conducted at the discretion of the senior member conducting the examination.

### Operational Propulsion Plant Examination (OPPE)

The OPPE is conducted under the following circumstances:

- No more than 6 months after the end of a repair period during which an LOE was conducted
- The interval between subsequent examinations will be approximately 18 months

It is considered essential that a ship successfully complete an initial LOE. A subsequent satisfactory OPPE is considered essential before a ship certifies as fully ready for fleet operations or sails on deployments. Except for ships homeported on the Mediterranean, OPPE will not normally be conducted on ships under the control of Commander-in-Chief, United States Naval Forces, Europe (CINCUSNAVEUR).

Reports of corrective action subsequent to an examination will be submitted as specified by the FLTCINC, with information copies forwarded to CNO and NAVSEASYSCOM.

## BOARD OF INSPECTION AND SURVEY (INSURV)

CNO administers INSURV. An INSURV board consists of a flag officer as president and such other senior officers as may be required to help him carry out the board's duties. Regional boards and subboards are established as necessary to help an INSURV perform its

duties. The subboards consist of a captain as senior inspector and about 10 other members, depending upon the type of ship that is to be inspected. The president of the INSURV board determines the procedures the board, and any regional board or subboards will follow to conduct trials, inspections, and surveys.

Ships are presented to the INSURV board for builders' trials, final contract trials, material inspections, and surveys. A ship being inspected or undergoing trials by INSURV is considered to be on detached duty until the trial or inspection is completed.

**INSURV Material Inspection**

INSURV material inspections are conducted according to statutory requirements of Congress. Those statutes specify the material inspection of a U.S. Navy ship (1) upon the ship's return from a foreign station, (2) at least once every 3 years (if practical), (3) when fitness of the ship for further service is in doubt, and (4) when the ship has been declared unfit and stricken from the Naval Vessel Register.

OPNAVINST 5420.70 describes the organization of an INSURV board, including the regional boards and subboards. OPNAVINST 4730.5 establishes the policy used to conduct an INSURV material inspection of each active ship 4 to 6 months before the ship's next scheduled regular overhaul. INSURVINST 4730.8 provides detailed guidance for the preparation and distribution of INSURV reports.

The INSURV board and the type commander agree on the time and place for a material inspection. The inspection starts promptly upon arrival of the board, and the ship must be moored to a pier or dock during the inspection so that machinery may be disabled. INSURV material inspections are not normally scheduled during regular overhaul or tender availabilities, and repair work during an inspection should be kept to a minimum.

The ship's personnel should submit a list of work items to the board conducting the inspection. The list should include all known or suspected work needed to bring the material condition of the ship to the required standard. The list should include the following work items:

- Departures from CNO-approved characteristics, contract plans, or specifications
- Incomplete or unsatisfactory tests
- Alterations desired
- Outstanding field changes of ship alterations
- Equipment required by approved plans
- Partially complete installations
- Safety hazards
- Repairs required
- Equipment that fails to meet performance requirements, requires excessive maintenance, leaks excessively, is obsolete, is in excess of actual needs, or is unreliable in operation
- Work items outstanding from previous trials or material inspections

The ship's personnel should prepare the list of work items according to INSURVINST 4730.5 and deliver a set to the board when they arrive. After the material inspection, the board members may make changes and assign classification and identification symbols. They will then forward copies of the corrected list, and any items they have added, to the ship and the type commander.

The INSURV board uses Arabic numerals and combinations of lowercase letters to identify work items as to reference number within the ship's departments such as (1, 2, 3) and the department or division of the ship having responsibility of the item. They use the following symbols to identify the ship's department or division having primary responsibility for a work item:

| | |
|---|---|
| nv | navigation department |
| op | operations department |
| wp | weapons department |
| dk | deck division or department |
| mp | main engines division |
| br | boilers/reactor division |
| ax | auxiliaries division |
| el | electrical division |
| dc | repair division (damage control and hull structure) |
| sp | supply department |
| rp | repair department |
| md | medical and dental departments |
| hb | habitability |
| av | air department |

The INSURV board inspects all parts of the ship, including storerooms, magazines, operating spaces, voids, cofferdams, chain lockers, and tanks. The ship's crew will open the spaces for inspection according to detailed instructions on the condition sheets. Someone who is responsible for each space must be available to open the space as soon as the inspection party arrives, to answer any questions about the space, and operate any equipment in the space.

The inspection team will examine the operation of all equipment and material during the INSURV inspection. The exception is equipment opened or disassembled for a more detailed inspection. Examples of equipment that will be operated include the following:

- Anchor engines
- Steering engines
- Deck machinery and rigging
- Lifeboat handling equipment
- Boiler safety valves on steaming boilers
- Overspeed tripping devices on generators and pumps
- Soot blowers
- Fire control systems
- Gun and missile batteries (in all methods of control)
- Hoists
- Sprinkling systems
- All electronic equipment

The INSURV board members in attendance are considered to be the prime working group on board the ship. The ship will furnish a stateroom for each member. Each stateroom will have chairs and a writing desk where the member can complete any inspection paper work in private. The ship will also furnish each board member a flashlight and a foul weather jacket, and board members who will inspect the hull will be furnished a scraper and chipping hammers. Department heads, or their representatives who are qualified to answer any operational and material questions, must be prepared to accompany each board member.

During the material inspection, members of the INSURV board must have access to the following records:

- Booklet of General Plans
- Ship Information Book (SIB) (all volumes)
- Records of watertight integrity tests
- Damage Control Book
- COSAL
- Departmental logs and performance records
- Waivers authorizing inactivation of major machinery and equipment (other then those disabled for the inspection)

  Preventive maintenance history

  Corrective maintenance history

  Complete list of approved outstanding alterations

  Lists (by department) of items of major machinery and equipment inoperative due to lack of material and/or test equipment

  Ship's copy of the work items prepared for the INSURV inspection

When the inspection is complete, the INSURV board will hold a critique. Each member of the board reviews the results of his inspection, and the ship's officers have an opportunity to comment on the board member's remarks. For small ships with relatively inexperienced department heads, each board member reports his results in enough detail to be sure the commanding officer understands the conditions. Work items covering deficiencies that were corrected before the critique are removed from the work list.

The senior member of the INSURV board submits a complete report of the results of the inspection to the president of the INSURV board. He also sends copies to the appropriate type commander and other interested commands, bureaus, and officers of the Department of the Navy. The report includes the departmental evaluations, the inspector's remarks, and the list of work items. The INSURV board does not assign a numerical grade or particular award of merit, but simply finds that the ship is in a satisfactory or unsatisfactory material condition of readiness for war or for further naval service.

When an inspection discloses a significant unsatisfactory condition, the senior member of the inspecting board sends an advance report in the form of a speedletter to the president of the INSURV board. Its purpose is to be sure the ship begins corrective action immediately. He sends the report no later than the day

after the inspection is complete and includes only those deficiencies that are considered to be important to the top levels of OPNAV and to fleet and type commanders. He sends copies of the report to the appropriate fleet and type commanders and other interested commands, bureaus, and offices of the Department of the Navy.

If the inspecting board believes the condition of the ship reflects credit or discredit upon any officer attached to the ship, that opinion is sent in a separate letter to the officer's reporting senior with a copy to the officer concerned.

### INSURV Surveys

Whenever CNO considers a ship to be unfit for further service because of its material condition, obsolescence, or other reasons, INSURV conducts a survey of the ship. After a thorough inspection, the board sends an opinion to the Secretary of the Navy as to whether the ship is fit for further naval service or can be made so at reasonable cost. If the board believes the ship is unfit for further service, and the cost of repairs or modernization is excessive, the board recommends that the ship be disposed of according to applicable law.

## ENGINEERING OPERATIONAL SEQUENCING SYSTEM (EOSS)

The EOSS is a complete set of technically correct, properly sequenced, operational and casualty control procedures developed for each ship type and configuration. OPNAVINST 9200.3 establishes EOSS as the basic guide for propulsion plant operations and casualty control. It further defines responsibility for the system's development, review, distribution, training, installation, use, monitoring, and updating.

EOSS standardizes operational techniques for watch standers and casualty control practices. A qualified watch stander can use the system to align, start up, operate, and secure propulsion plant equipment during normal operations and casualty conditions. EOSS consists of the procedures, charts, diagrams, and reference documents necessary to accomplish major steady-state changes in the propulsion plant and to respond to the most frequently occurring casualties. EOSS is divided into two major subsystems: Engineering Operational Procedures (EOP) and Engineering Operational Casualty Control (EOCC). Both are discussed in greater detail later in this chapter.

EOSS includes the procedures necessary for each ship to proceed from shore services (cold iron) to auxiliary operation, to under way, back to auxiliary operation, and back to shore services. Each EOSS package includes procedures and tank tables to transfer fuel oil internally and to refuel, defuel, ballast, and deballast all engineering propulsion plant fuel tanks. EOSS also provides the following advantages:

- Uniform operating criteria throughout the fleet
- Effective use of available personnel and equipment to standardize EOPs and EOCC practices
- Document procedures for normal/casualty operation and training support

## ENGINEERING OPERATIONAL PROCEDURES (EOP)

The EOP section of EOSS is a set of standardized, technically correct, written procedures for the normal operation of a ship's engineering propulsion plant. EOP documents list the steps and systems alignment required for normal engineering plant evolutions. EOP does not address abnormal systems alignments or those required for maintenance, battle damage, or other specialized evolutions. EOP is detailed enough to provide directions to a watch stander who can use it to perform operations without deviation from the written document.

It is necessary to develop EOP parameters because of the large number of equipment combinations, plant alignment configurations, and steaming conditions in an engineering propulsion plant. The EOP is developed using the following parameters:

- All equipment is fully operational within design operating limits.
- All watch areas are manned by qualified watch standers.
- Only authorized ship alterations are recognized.
- Valves are labeled according to the SIB.

The EOP must contain the following documentation: master prelight-off checklist, master plant procedures, operational procedures, equipment status charts, optimum generator combination chart, valve status diagrams, system procedures, component procedures, system diagrams, oil king procedures, tank tables, EOP Record of Revisions Page, and EOP Index.

## ENGINEERING OPERATIONAL CASUALTY CONTROL (EOCC)

EOCC provides propulsion plant watch standers with procedures to handle casualties. There are too many possible casualties in a propulsion plant to provide documentation to address all of them. Therefore, EOSS is limited to the most commonly Occurring and comprehensive casualties. This selecting process provides the maximum coverage with minimum documentation.

EOCC details the watch area actions and communications necessary to recognize casualties, control action, and prevent impending casualties. It describes the immediate action to isolate a casualty when it cccurs, and the supplemental action to place the engineering plant in a stable condition until it can be restored or must be completely secured. EOCC interfaces with EOPs for “stopping during a casualty” and “starting after a casualty.”